Zentrum für Technomathematik

O^2C Optimization & Optimal Control

Robust Nonlinear Dynamic Parameter Identification using Decomposition of Nonlinearities

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For the optimization of a given application a realistic model is needed. In many applications a system of ordinary nonlinear differential equations is used to describe the dynamic behavior of a given situation. To increase accuracy in general these models depend on some parameters (e.g. efficiency coefficient, capacities or diameters) which have to be adapted concerning some measurements. This task can be done automatically with mathematical optimization techniques (e.g. sequential quadratic programming).

Using the conventional approach (solve the ode system numerically in every optimization iteration to calculate the value of the objective function) the resulting objective function is highly nonlinear. In order to receive a good fit with given measurements a very good initial guess for the parameters is required. The very high sensitivity of the objective function regarding small changes of the parameters in nonlinear ode systems causes many difficulties during the optimization process.

In this work the concept of decomposition of nonlinearities is used to design a robust and efficient algorithm to solve nonlinear dynamic parameter identification problems. The integration of the ode systems is proposed to be performed within the optimization process which leads to a high dimensional optimization problem with many constraints (depending on the dimension of the given data). Using the sparse SQP method WORHP the solution of the large scaled optimization problem can be done efficiently.

The benefits and the latest results of this technique will be illustrated by an application of a turbocharger design within a framework with more than 2 million variables and constraints.